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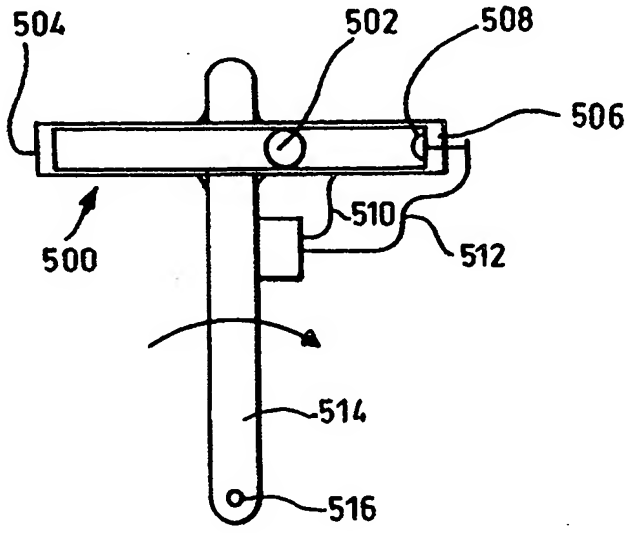
(54) Title: VISUAL IMAGE DISPLAY DEVICES WITH MOVING LIGHT EMITTER ARRAYS AND SYNCHRONISATION DEVICES THEREFOR

(57) Abstract

A device for displaying a two dimensional image to a viewer may comprise a light pattern generator (1) and a control unit (3) connected to the light pattern generator for causing the generator to produce a sequence of light patterns corresponding to respective different portions of said image. Due to the movement of the generator and the viewer's persistence of vision, the viewer sees what appears to be said two dimensional image. The generator can be incorporated in an item of apparel such as a wrist band (6) or a shoe (16). The image displayed could comprise an advertising slogan or designer label. In another embodiment, light patterns produced by a pattern generator are incident on a rotating plate and reflected via a transparent cylinder to a viewer. In yet further embodiments, the display system may comprise an LED array (110 Figure 7), (302 Figure 10) or (401 Figure 12) arranged on a bicycle wheel, yo–yo, spinning top or the like, the arrays being controlled by control means which is responsive to gravity switch (118) or radiation sensing switch (RxTx,403).



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VISUAL IMAGE DISPLAY DEVICES WITH MOVING LIGHT EMITTER ARRAYS AND SYNCHRONISATION DEVICES THEREFOR

The present invention relates to visual display devices.

There has been proposed a visual display device for displaying a two dimensional image to a viewer comprising a light pattern generator and a control unit for causing the pattern generator to produce a sequence of light patterns corresponding to respective different portions of said image such that, due to relative movement of the viewer and the generator and the viewers persistence of vision, the viewer sees what appears to be the overall two dimensional image.

Such a proposed device may be implemented as a system for displaying advertising material or information to travellers on underground trains, the light patterns being projected onto or displayed from the wall of the train tunnel so that a viewer sees them one after another from inside the train but because of his persistence of vision, there being seen the overall image. The proposed device could also be implemented as a display system for being fitted to a member mounted for turning movement, e.g. a cycle wheel so that, as the member turns, an image such as a designer logo is displayed. Where the member is a cycle wheel, the image is displayed to people watching the passing cycle rider.

According to one aspect of the present invention, there is provided a device for displaying a two dimensional image to a viewer, the device comprising a light pattern generator incorporated in an item of apparel for being worn by a wearer and for being moved by the wearer relative to the viewer, and a control unit connected to the light pattern generator for causing the generator to produce a sequence of light patterns corresponding to respective different portions of said image such that, due to the movement of the generator and the viewer's persistence of vision, the viewer sees what appears to be said two dimensional image.

According to a second aspect of the invention, there is provided a device for displaying a two dimensional image to a viewer, the device comprising a light pattern generator incorporated in support means for being moved vertically up and down relative to said viewer, means for determining the reciprocation rate of the support means and a control unit connected to the light pattern generator and the reciprocation rate determining means for causing the generator to produce a sequence of light patterns corresponding to respective different portions of said image such that, due to the movement of the generator and the viewer's persistence of vision, the viewer sees what appears to be said two dimensional image comprising said portions one above another.

According to a third aspect of the invention, there is provided a device for displaying a multi-dimensional image to a viewer, the device comprising a light pattern generator, a reflective member mounted for turning movement relative to said viewer, and a control unit connected to the light pattern generator for causing the generator to project onto the reflective member a sequence of light patterns corresponding to respective different portions of said image, the light patterns being operable to be reflected to said viewer such that, due to the movement of the generator and the viewer's persistence of vision, the viewer sees what appears to be said image. This image can be a two-dimensional image or even a three-dimensional one providing a pattern generator comprising suitably arranged multiple light sources are used.

In each aspect, the image displayed could comprise alphanumeric information, an advertising slogan or designer logo, a film clip or other visual information.

This invention also relates to improvements in a display system as mentioned earlier, namely for producing an image of alphanumeric characters and/or other material on a member which turns, for example, a rotary member such as a wheel of a bicycle or other vehicle.

Thus, according to another aspect of the present invention, there is provided a display system for being fitted to a member which is subject to turning movement, the display system comprising light pattern generating means, control means including memory means and connected to the light pattern generating means for causing it to produce a sequence of light patterns in accordance with signals stored in said memory means, and position sensing means connected to the control means for sensing the position of the member within said turning movement, the position sensing means comprising an element which is able to move in response to gravity and signal supply means for supplying an electrical signal indicative of the movement of the element.

Preferably, the movable element comprises electrically conductive material and the signal supply means comprises a pair of contacts within the position sensing means for being bridged by the movable element in one position thereof in its movement.

The display system may include centrifugal switch means for responding to turning of the said member for initiating operation of the system.

Said position sensing means is preferably fitted to said member for the movement of the movable element to be transverse to centrifugal force acting on the element due to the turning movement of said member.

According to a further aspect of the invention, there is provided a display system for being fitted to a member which is subject to turning movement, the display system comprising light pattern generating means, control means including memory means and connected to the light pattern generating means for causing it to produce a sequence of light patterns in accordance with signals stored in said memory means, and position sensing means connected to the control means for sensing the position of the member within said turning movement, the position sensing means comprising an infrared transmitter/receiver combination fixed to said member and operable for co-operating with an item which does not turn with said member, thereby to cause a signal to be produced from the infrared receiver.

According to yet another aspect of the invention, there is provided a display system for being fitted to a member which is subject to turning movement, the display system comprising light pattern generating means, control means including memory means and connected to the light pattern generating means for causing it to produce a sequence of light patterns in accordance with signals stored in said memory means, and position sensing means connected to the control means for sensing the position of the member within said turning movement, the position sensing means comprising radiation sensing means for sensing radiation from separate radiation transmitting means.

The display system may be comprised in a toy spinning top, yo-yo, model aircraft or the like.

According to one more aspect of the invention there is provided a switching system for providing an electrical output signal indicative of the speed and angular position of a rotary member rotating about an axis having a component extending in a horizontal plane, the system comprising a guide rigid with the rotary member for guiding a body for movement along a path radially spaced from said axis such that when the member is rotated the gravitational pull on the body exceeds any centrifugal force on the body and so allows the body to shift from one end of the path to the other as the member rotates, and switch means operated each time said body reaches a predetermined position along said path.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:-

Figure 1 is a simplified circuit diagram of a first display device;

Figures 2 and 3 are respective diagrams for showing how the device of figure 1 displays images;

Figure 4 is a rear view of a shoe comprising a second display device and two outline rear views of the same shoe at different positions during vertical movement of the shoe;

Figure 5 is a simplified circuit diagram of the second display device;

Figure 5a is a front elevation of pressure switch.

Figure 6 is a diagrammatic perspective view of part of a third display device;

Figure 7 is a diagram of part of a bicycle with an image display;

Figure 8 is a block diagram of the display system in conjunction with a re-programming system;

Figure 9 is a diagram of the position sensor;

Figures 10 and 11 are respectively a perspective view and a side view of a yo-yo;

Figure 12 is a diagrammatic side view of a spinning top;

Figure 13 is a diagrammatic side view of a helicopter.

Figure 14 is a front elevation of a gravity switch;

Figure 14a is a waveform of the output of from the switch of tape Figure 14; and

Figures15 and 16 are front elevations of two further modified display devices.

The first display device comprises a light pattern generator 1 which takes the form of a curved linear array of light emitting diodes 2 mounted on a board attached to a wristband 6 (see Figure 2) to be worn around the wrist or ankle for example of a jogger, footballer or other sportsman. The display device further comprises a microprocessor based control unit 3 connected to the diodes 2, two movement sensors 4 and 5 (for sensing movement of the wristband in two orthogonal directions) connected to the control unit 3, and a power cell or battery 7. The control unit 3 and sensors 4 and 5 are not shown in figures 2 and 3 but, along with the power cell or battery 7, are secured to the wristband 6.

The control unit 3 includes a semiconductor memory (not separately shown) in which there is stored a control programme for the control unit and also data representative of a two dimensional image to be displayed. In response to the image representative data and the signals from the sensors 4 and 5 and movement of the wristband, the control unit modulates the illumination produced by the individual light emitting diodes 2 of the light pattern generator so as to form consecutive linear patterns of light corresponding to adjacent linear sections of the image.

The wristband 6 is worn such that the generator 1 can be seen by an observer (not shown) positioned to one side of the wearer (not shown). The light pattern generator 1 and the light patterns produced thereby move with the wearer's wrist relative to the observer. The signals formed by the sensors 4 and 5 are indicative of the horizontal and vertical components of this movement.

In fact, this particular display device is intended for use where the relative movement consists mainly of the absolute movement of the light pattern generator 1, the observer being more or less still. For example, the wearer and the observer might be a player and a spectator respectively at a sporting event. Thus, the sensors 4 and 5 are operable to sense horizontal and vertical movement of the pattern generator relative to the ground.

Although the linear patterns of light are presented to the observer one after another, this is done sufficiently rapidly so the observer sees what appears to be the overall two dimensional image made up of the adjacent image sections. This is due to the movement of the patterns relative to the observer and the persistence of the patterns in the observer's vision.

The production of the light patterns is controlled according to the speed and direction of movement of the pattern generator 1. However, the signals from the sensors 4 and 5 may be directly or indirectly representative of speed - for example, the sensors could comprise accelerometers (such as disclosed hereinafter with reference to Figure 14). If the signals are indirectly representative of speed, the device may comprise additional signal processing circuits (not shown). Alternatively, the microprocessor (not separately shown) of the control unit 3 may be operable to calculate the values of the speed components, or may be operable simply to take the signals from the sensors 4 and 5 into account without necessarily calculating those values as such. The array of light emitting diodes 2 is curved so that, for the observer, the array always has both a vertical and a horizontal dimension and an image may be formed when the direction of movement of the array relative to the observer is either horizontal or vertical. Thus, in figure 2 where the wristband 6 is moving in the horizontal direction, there may be seen a two dimensional image 7, this being made up of side by side sections. By contrast, in figure 3, the wristband 6 is moving vertically and the image 8 which is displayed is made up of sections one above another. Thus, for coincident images 7 and 8, for example if both images are to comprises the same word reading horizontally, the sequences of light patterns are different.

The curved array of light emitting diodes 2 could be replaced by a straight linear array (not shown).

It is not essential for the production of the light patterns to be controlled in dependence upon the speed of movement of the pattern generator since, at least in some actions by the wearer, the speed may be reasonably constant. Similarly, a particular direction of movement may be assumed. Thus, it may be possible to discard the sensors 4 and 5 altogether.

The wristband 6 may be formed as a strip of material incorporating a Velcro (TM) quick release fastener (not shown) so that it can be worn on the forearm or elsewhere on the body or attached to another item of clothing. The strip could be attached permanently to any such other item of clothing if desired or the display device could be incorporated directly into the item of clothing, or it could be attached to or incorporated in other carried or worn equipment or apparel.

The display device shown in figures 4 and 5 comprises a light pattern generator 11 in the form of a horizontally extending linear array of light emitting diodes 12 fixed to or incorporated in the heel of a shoe 16 so as to be visible to an observer (not shown) behind the person wearing the shoe. Also fixed to or incorporated in the shoe 16 are a microprocessor based control unit 13, a pressure sensor 14 and a power cell or battery (not shown).

As the person wearing the shoe walks, runs, jumps or otherwise moves with respect to the floor 15, the shoe and hence also the light pattern generator 11 moves repetitively up and down (figure 4 contains outline diagrams of the shoe at the middle and top of its movement as well as the view seen when it is in contact with the floor 15). The pressure sensor 14 generates a signal pulse whenever the shoe touches the floor and these successive pulses are fed to the control unit 13. Figure 5a is an example of a pressure switch 14 and includes an electrically insulating base 40 supporting a conductive pattern 42. An annular deformable pad 44 of electrically insulating material supports a conductive plate 46. The pattern 42 and plate 46 are connected to respective ones of a pair of terminals 48 and 50. Pressure on the plate 46 will compress the pad 44 until the plate contacts the pattern 42 to cause a short circuit across terminals 48 and 50. The pressure switch 14 may be replaced by a piezoelectric element.

The control unit includes a semiconductor memory (not separately shown) containing a control programme and data representative of a two dimensional image to be

displayed. In response to this image data, the control unit modulates the illumination produced by the individual light emitting diodes 12 so as to present to the observer a sequence of linear light patterns corresponding to respective adjacent sections of the image. Due to the movement of the shoe relative to the observer, and the rapid change form one pattern to the next in the sequence, the observer sees what appears to be the desired two dimensional image 17 made up of the different image sections one above another.

The sequence of light patterns is repeated during each upward movement of the shoe and, optionally may also be generated in reverse when the shoe is moving downwards. Thus the image is displayed repeatedly, at least each time the shoe is moving upwards and preferably also each time the shoe is moving downwards. The function of the signal pulses from the pressure sensor is to synchronise each repetition of the sequence with the movements of the shoe. Also, from the lengths of the time periods between successive pulses, the control unit is able using an appropriate algorithm to estimate the speed of movement of the shoe at any instant and hence correctly to control the repetition rate at which the successive light patterns should be produced to give the best display, i.e. so that the same image is displayed each time the shoe moves up or down. Because of the fact that the speed of the shoe is somewhat sinusoidal the control system which controls the energisation of the diodes is programmed so that the on-period of each divide will vary as a function of the position of the shoe; the shortest on-period occurring when the shoe is moving fastest so as not to distort the image as seen by a stationary observer. The algorithm takes this into account.

Instead of facing backwards from the heel of the shoe, the light emitting diode array could be incorporated in the side of the heel or the front part of the sole of the shoe or the array could even extend around the heel and then along one or both sides of the shoe. Instead of a pressure sensor, the device could include a force, speed or acceleration sensor (not shown). In these cases, the signals from the sensors are again supplied to the control unit 3 but now the control unit can sense both the upper and lower limits of the movement of the shoe.

The sequence of light patterns may be repeated more than once during each upward movement and then again during each downward movement of the shoe, i.e. so the observer sees two or more images one above the other.

Instead of a shoe, the device as described with reference to figures 4 and 5 could be implemented in some other item or device that moves generally vertically up and down with respect to a viewer.

In another display device according to this invention, there is projected an image onto a rotating sheet of glass, or other transparent, semi-transparent or semi-reflective surface such that, as the sheet rotates, the image is visible apparently suspended in space with the natural background to the device visible through the image. The device projects the image as a series of dots or lines, these are incident on the sheet and reflected to the viewer. The sequence of flashing lines and dots forms an image which, in effect, is scanned by the sheet and presented to the viewer. The device and the rotating sheet are electronically linked such that a coherent image is formed.

Figure 6 shows a flat rectangular plate 20 supported by bearings 21 for rotation about an axis 22. The axis 22 lies in the plane of the glass plate 20 parallel to and midway between its two long sides. The plate is surrounded by the wall 23 of a transparent or translucent hollow cylindrical member 24 which is coaxial with the axis 22. The rotation of the glass plate is driven by an electrical motor and gearbox combination 25 via shaft 26.

A light pattern generator 27 in the form of a linear array of light emitting diodes 28 (or alternatively a planar matrix array comprising several adjacent parallel lines of such diodes) is supported by a mounting means (not shown) adjacent the cylindrical member 24 so the that the array extends parallel to the axis 22 and light patterns formed by the generator 27 are incident upon the glass plate 20. Meanwhile, however, the diodes 28 of the generator are obscured by shielding means (38) e.g a channel shaped guard so that light from the diodes is not generally directly viewable.

The diodes are connected to respective drive signal outputs of a microprocessor based control unit 29 which, in turn, receives trigger signals from a series of transducer elements 30 fixed to the top inside surface of the wall 23 and equally spaced around the axis 22. The trigger signals are supplied in response to the movement past the respective transducer elements 30 of a counter-element 31 fixed to one of the top corners of the glass plate 20. By way of example, the counter-element could comprise a magnet and each element 30 responsive to the field produced by the magnet (e.g. a magneto structure resistor).

The control unit 29 modulates the light produced by the individual diodes 28 so as to project onto the glass plate 20 repeated sequences of consecutive linear patterns of light

corresponding to respective adjacent sections of the two dimensional image which is to be presented to the viewer (not shown). The patterns are then reflected by the glass plate 20 towards the viewer via the wall 23 of the cylindrical member 24. Each sequence of patterns, corresponding to whole image, is repeated in response to each trigger signal from one of the transducers elements 30 so that, in response to the trigger signals from any one transducer element, successive identical sequences of patterns are presented to the viewer with each pattern corresponding to a particular image section at the same position in the viewer's eye but with the successive patterns corresponding to adjacent sections apparently side by side. Due to the viewer's persistence of vision, the viewer sees only what appears to be the overall two dimensional image. Instead of successive identical sequences of patterns, they may change to give moving images.

Meanwhile however, because there are several transducer elements, the overall image is presented to the same or different viewers at several different viewpoints around the device.

Instead of providing several transducer elements, the programme within the control unit 29 can be operable to produce the several image displays. Furthermore, the programme could be operable to produce effects such as the displayed image, an alphanumeric message for example, rotating slowly within the cylinder. This may be done by gradually increasing or decreasing the delay period between the start of each sequence of light patterns and the respective times at which the glass plate 20 comes to a particular position in its rotation, e.g. the time of a particular trigger signal if the or one of the transducer elements 30 is being

used to sense the position of the plate.

Note though that it is not essential to sense the plate position because variation of the delay period mentioned above amounts simply to providing a difference between the repetition period of the light pattern sequence and the motor speed.

Instead of glass, the plate 20 may be made of some other transparent material. The plate may also be semi-transparent or reflective and both the plate 20 and the wall 23 of the cylindrical member 24 could comprise parts having non-reflective coatings to prevent the projection of unwanted spurious images.

The light emitting diodes 28 in the light pattern generator 27 could be replaced by suitable alternative light sources.

One alternative light source may comprise a laser and means to deflect the laser beam along a vertical slot in the wall of the cylinder. By pulsing the laser and simultaneously causing the laser to scan the slot the same effect can be produced as that produced by the array of diodes.

Scanning can be effected in a variety of ways. In Figure 15 a laser 60 is caused to scan a slot 62 leading to the rotating plate 20 with the aid of a rotating hexagonal mirror 64. Each of the six surfaces of the mirror 64 causes the laser beam to scan the slot 62. In order to avoid any dangerous emissions from the laser reaching the viewer either the cylinder 24 or the plate 20 is of light diffusing material but not the slot 62 which is shielded from view.

In the modification shown in Figure 16 instead of the rotary mirror 64, an oscillating mirror 66 is provided which oscillates about a pivot 68. An armature 70 attached to the rear of the mirror is attracted when a coil 72 is energised to move the mirror 66 in an anticlockwise sense about the pivot 68. A spring 74 biases the mirror 6 in the opposite sense so that when energisation of the coil 72 is discontinued the mirror 66 will return to its original position. In this way the beam of the laser will be caused to effect successive scans of the slot 62.

It will be appreciated that instead of a simple laser, three lasers in respective ones of the primary colours can be used to create a full colour representation. Also by appropriate manipulation of the laser beam three dimensional, holographic images can be created.

The plate 20 may be rotated in opposite directions or it may be oscillated back and forth in dependence upon whatever display effect is desired.

Control units used in display devices according to the invention, for example the control units 3, 13 and 29 in the illustrated display devices, could each comprise a microcontroller connected between a read-only memory and a light emitting diode driver, the driver having respective drive signal outputs connected via current limiting resistors to the light emitting diodes. None of the microcontroller, read-only memory and light emitting diode driver, nor any of the current limiting resistors, is shown separately herein. The read-only memory may comprise a programmable erasable memory, preferably electrically erasable, so it can be re-programmed from time to time to generate new images.

Also, the programme and data stored in the control unit could be representative of several different images and operable for these different images to be displayed one after another. The or each two-dimensional image could comprise only image elements which are fixed with respect to one another, or it could comprise apparently moving items, and the

image could comprise one or more different colours. To produce a multi-coloured image, the light pattern generator in each device may comprise colour controllable diodes or it could comprise clusters of single colour diodes, say red, green and blue, with the control unit set to vary the relative durations of pulses of the different colours.

In each embodiment described, instead of a light pattern generator comprising an exposed array of diodes so that the light patterns are received directly therefrom, the diodes could be positioned elsewhere and re-arranged, not necessarily as a linear array, but then respective fibre optic elements are provided, each fibre optic element receiving at one end the light from the diode and transmitting it to the active face of the pattern generator, i.e. so in each case the light is received from the other end of the fibre optic element instead of direct from the diode. These other ends of the fibre optic elements are then arranged as a curved or straight array as required.

A display device according to the invention, could comprise a display unit which, instead of a single line of light emitting diodes, could comprise diodes arranged in some other pattern, for example a generally linear array with several adjacent lines of diodes, each line being relatively long compared to the distance between the outer two lines. In such a generally linear array, the number of diodes in each line best exceeds the number of adjacent lines by a multiple of at least eight or twelve, or better still sixteen or more. Each image section then comprises several adjacent light patterns all formed at the same time but the observed image still comprises consecutively generated image sections, and the relative movement of the pattern generator and observer and the observer's persistence of vision are effective to form the overall image.

Persistence of vision refers to the inability of the human eye to discriminate viewed image changes in a very short time span, say less than 0.015 second. For example if two separate flashes of light are presented to the viewer within this time, the viewer will see what appears to be only one flash or, if the flashes are presented from different positions within the viewer's vision, the viewer will see the two flashes from the different positions but apparently at the same time. Thus, for the viewer to see a composite image made up of a series of adjacent image components as in the display devices shown herein, each sequence of light patterns is generated within the above mentioned very short time period, preferably less than 0.05 seconds or better less than 0.04 seconds or even better less than 0.03 seconds or better still less than 0.02 seconds or best of all less than 0.015 seconds or less.

Figure 7 shows part of a bicycle having a front wheel 104 carrying an illuminated image of the registered trade mark REEBOK which, to the stationery observer, appears stationary on the bicycle notwithstanding that the wheel 104 is rotating.

The wheel 104 is supported by a fork 106. Attached to one spoke 108 of the wheel 104 is an elongate array 110 comprising sixteen light emitting diodes (LEDs) extending radially of the wheel 104. Also mounted on the same spoke 108 is a controller 116, which includes a battery (not shown), and is connected to the array 110. The imbalance caused by the attachments to the wheel can be corrected by the use of counterweights (not shown) attached to the diametrically opposite side of the wheel.

As shown in Figure 8, the controller includes a microcontroller 117 and an LED driver 119. Also, a memory 120 that stores a program for controlling the sequence in which the different LEDs of the array are to be energised. By selecting the timing and energisation of the different LEDs in accordance with a predetermined program, the observer will see an apparently stationary image on the wheel notwithstanding that it is rotating.

The effect is achieved because with light flashes of very short duration, the reaction of the human eye to the flash persists long after the flash has finished. Thus, where a series of very short flashes occur over a short time span, less than 0.015 seconds, all the flashes appear to the eye to have occurred at the same time and when the flashes are spaced from one another on the retina, because the array has moved relative to the retina, the eye perceives a composite light pattern which will persist for a short while immediately following the time span. It will thus be appreciated that a program can be created and stored in the memory which will produce almost any desired image for the observer. The image may take the form of alphanumeric information or may take the form of an advertising poster.

In order for the viewed display to start at a particular angular location on the wheel and to prevent drift due to a change in speed of the wheel, the rotation of the wheel has to be sensed. A position sensor 118 is mounted on the spoke 108. As shown in Figure 9, the position sensor 118 comprises a housing 120 containing a ball bearing 122 and, at one end 124, two contacts 126. The ball 122 can move in housing 120 and, at an appropriate point in the rotation of wheel 104, supply an electrical signal to controller 116. Control means (not shown) within the controller 116 responds to the signal to initiate the readout from the

memory at the same angular position of the spoke 108 during each full cycle of rotation of the spoke.

Thus, the start point of the image will always be in the same position. The control means also measures the repetition rate of the operation of the sensor 118 and inhibits a readout from the memory until the speed of the wheel reaches 35rpm. After this point has been reached, the control means controls the readout rate from the memory to the array directly in proportion to the instantaneous repetition rate determined by the control means.

Ball 122 moves in response to gravity G. However, as shown in Figure9, the sensor housing 120 is arranged on wheel 104 so that the movement of the ball 122 is perpendicular to spoke 108, i.e. transverse to the direction of centrifugal force F on ball 122 due to rotation of wheel 104. Figure 9 shows sensor 118 in respective positions of the wheel which demonstrates this.

As an alternative to the control means determining the wheel speed to inhibit or allow operation of the system, the system could comprise a centrifugal switch (not shown) which initiates, e.g. powers up, the display system.

The figures also show how the memory of the controller 116 can be programmed. As shown, a desired image is created with the aid of an IBM PC compatible computer 200 and configured as a 200 x 16 pixel array. The array is downloaded into a programmer 201 which coverts the driving data stream into a processor compatible processing stream. The processor in turn loads the program for the array into the memory of the controller via plug and socket interface 202.

It will be appreciated that instead of a battery, power can be induced into the controller from a rotary part of the bicycle using an induction system.

As an alternative, power can be fed from a source mounted on the bicycle frame to the wheel through a slip ring arrangement.

While the display system has been described in connection with a bicycle wheel, it will be appreciated that it can be applied to any other rotating member for example to an automobile wheel (or hub caps therefor) or a funfair wheel.

The bicycle may include an electric speedometer (not shown) which derives its input, i.e. the pulse repetition rate of the sensor 118, from the controller.

The controller 116 can be in two parts, a first part fixed to the spoke and a second part which can be plugged into the first part and which contains the power supply (the

batteries) and the memory. The plug-in part can be removed for security purposes and/or to reprogram the memory.

As shown in Figures 10 and 11, instead of a bicycle wheel, the rotary member could comprise the kind of device known as a 'yo-yo' i.e. a balanced reel 300 with string 301 attached and which can made to wind itself up and down the string.

An LED array 302 is attached to one face of the yo-yo to act in just the same way as the array on the bicycle wheel of Figure 7. Again, there is a controller 303 including an LED driver coupled to the array and a microcontroller connected to the driver. The position sensor here comprises an infrared transmitter and an infra-receiver fitted to the two walls of the yo-yo facing each other so that each time the string 301 breaks the link between the receiver and transmitter a position datum signal is produced and fed to the microcontroller. The time between the datum signals allow the speed of rotation to be calculated so that the image remains stationary. In addition, the controller may calculate the acceleration of the yo-yo (its speed changes at intervals as it changes direction at the top and bottom of its movements) so that it can allow for such changes and/or even to predict the next interval between pulses.

Figure 12 shows a spinning top 400 with an LED array 401. Again, a controller 402 is provided and a position sensor 403. The sensor 403 here takes the form of a radiation sensor which is responsive to a hand-held transmitter 404. The radiation may be infrared, radio or ultra-sonic.

The transmitter 405 could take the form of a remote control unit which also reprograms the controller 402 to produce different images when desired or to produce sounds from the top.

The top may be battery driven. Instead of a top, the same principal may be applied to a powered gyroscope or other inertial model.

As well as the transmitter 404, the top could communicate with other devices using infrared, ultra-sonic, visual light, etc.

As shown in Figure 13, a display device may take the form of an LED display 500 fitted to a toy helicopter 501 or other aircraft model suspended from say the ceiling 502 of a room. The LED display can be at the side or beneath the toy. The display can be made to run continuously or there could be a remote control unit (not shown) for changing the image and/or synchronising it as in Figure 12.

An accelerometer in the form of a gravity switch is more clearly shown in figure 14.

As shown a hollow tube 500 of electrically conductive material houses an electrically conductive body 502 (for example a ball bearing) which can move along the tube from one end to the other. The opposite ends of the tube 500 are closed by electrically insulating end caps 504 and 506. At least one end cap 506 has on its inner-face a central dome-shaped contact 508. A pair of electrical wires 510 and 512 are respectively connected to the tube 500 and the contact 508.

The tube is mounted on a support member 514 which rotates about an axis 516 having at least a component in the horizontal plane.

The tube 500 which lies radially spaced from the axis 516 has a longitudinal axis which has a component which extends perpendicular to the radial direction.

In operation when the member 514 is rotated about the axis 516, the body 502 within the tube 500 is subject to centrifugal force. If the axis of the tube extends generally at right angles to the radial direction the displacement of the body 502 along the tube due to centrifugal force will be zero or minimal. If the plane in which the tube rotates has a vertical component then gravity will act on the body 502 to displace it towards one end during each alternate half cycle and to displace it towards the other end during each intervening half cycle.

Thus body 502, the tube 50, the contact 508 and the wires 510 and 512 act as a switch which will close once every cycle of operation.

While the tube 500 is preferably rectilinear it may be slightly arcuate in either the concave or convex sense. This will cause some centrifugal force to be applied to the body 502 but provided that speed of rotation and the curvature is such that the centrifugal force does not equal or exceed the gravitational force on the body, the closure of the switch will still occur once every cycle.

The tube may have a cross-sectional profile other than circular in which case the body 504 should have a profile which will still allow it to slide or roll along the tube.

The acceleration of body 502 under the pull of gravity is likely to cause a bounce of the body 502 on the contact 508 with which it makes contact. The resultant output from the switch (if energised with a DC signal) will be a first square wave having a first pulse repetition rate with the second square wave having a much higher pulse repetition rate occurring at the rise of each pulse having the first repetition rate (see Figure 15).

Simple known circuitry can be used to filter out all but the square wave having the lowest repetition rate. The resultant signal thus not only provides an indication of the

speed of rotation of the ember 514 but an instantaneous indication of the position of the member 514 during each cycle.

The angle at which the instantaneous position of the member 514 is detected will vary as a function of speed but if this relationship is known then exact position of the member 514 will be known at least one in every cycle.

This accelerometer can be used in connection with any of the embodiments of Figures 1 to 3: 7, 8; or 10, 11.

CLAIMS

1. A switching system for providing an electrical output signal indicative of the speed and angular position of a rotary member rotating about an axis having a component extending in a horizontal plane, the system comprising a guide rigid with the rotary member for guiding a body for movement along a path radially spaced from said axis such that when the member is rotated the gravitational pull on the body exceeds any centrifugal force on the body and so allows the body to shift from one end of the path to the other as the member rotates, and switch means operated each time said body reaches a predetermined position along said path.

2. A system according to Claim 1, wherein said guide means comprises an elongate tube.

3. A system according to Claim 2, wherein said tube is rectilinear.

4. A system according to Claim 2, wherein said tube is slightly arcuate.

5. A system according to any preceding claim, wherein the tube is of circular cross-section and the body comprises a ball bearing.

6. A system according to Claim 5, wherein the tube and body are of electrically conductive material and the tube is closed at one end by an electrically insulating end cap supporting an inwardly directed contact member positioned to be engaged by said body.

7. A device for displaying a two dimensional image to a viewer, the device comprising a light pattern generator incorporated in an item of apparel for being worn by a wearer and for being moved cyclically by the wearer relative to the viewer, means for determining the cyclical frequency, and a control unit connected to the light pattern generator and the frequency determining means for causing the generator to produce a sequence of light patterns corresponding to respective different portions of said image such that, due to the movement of the generator and the viewer's persistence of vision, the viewer sees what appears be said two dimensional image.

8. A device according to Claim 7, including movement sensing means for sensing components of velocity and/or acceleration of the item in two directions extending at right angles to each other and feeding output signals to said control unit.

9. A device according to Claim 7 or Claim 8, wherein said item of apparel is suitable for being worn as wrist band.

10. A device according to any one of Claim 7 or 9, wherein the item of apparel comprises a disengageable fixing means operable for the item to be worn at alternative locations on the wearer's body.

11. A device according to any one of Claims 7 to 10, including sensor means connected to the control means for supplying signals indicative of the speed and/or direction of movement of the light pattern generator.

12. A device according to one of Claims 7 to 11, wherein said control means is operable for causing the patterns produced by the generator to be vary in dependence upon the speed and/or direction of movement of the light pattern generator.

13. A device according to any one of Claims 7 to 12, wherein the light pattern generator means comprises a generally linear array of light sources.

14. A device according to Claim 12, wherein the sources are light emitting diodes.

15. A device according to Claim 12 or 13, wherein the array of light sources is curved.

16. A device according to Claim 7, wherein the item of apparel is a shoe.

17. A device according to any one of Claims 7 to 16, wherein the frequency determining means comprise a system according to any one of Claims 1 to 6.

18. A device for displaying a two dimensional image to a viewer, the device comprising a light pattern generator incorporated in support means for being moved vertically up and down relative to said viewer, means for determining the reciprocation rate of the support means and a control unit connected to the light pattern generator and the reciprocation rate determining means for causing the generator to produce a sequence of light patterns corresponding to respective different portions of said image such that, due to the movement of the generator and the viewer's persistence of vision, the viewer sees what appears be said two dimensional image comprising said portions one above another.

19. A device according to Claim 18, wherein the support means is a shoe.

20. A device according to Claim 19 ,wherein the light pattern generating means comprises an array of light emitting diodes extending in a substantially horizontal plane around the heel of the shoe and/or the side of the shoe.

21. A device according to Claim 18 or 19, including sensor means incorporated in the support means for forming signals indicative of at least one position of the support means within its movement.

22. A device according to Claim 21, wherein the sensor means comprises pressure sensor means responsive to each occasion that the shoe is pressed against the ground.

23. A device for displaying a two dimensional image to a viewer, the device comprising a light pattern generator, a reflective member mounted for turning movement relative to said viewer, and a control unit connected to the light pattern generator for causing the generator to project onto the reflective member a sequence of light patterns corresponding to respective different portions of said image, the light patterns being operable to be reflected to said viewer such that, due to the movement of the generator and the viewer's persistence of vision, the viewer sees what appears be said two dimensional image.

24. A device according to Claim 23, wherein the reflective member comprises a reflective plate mounted for rotation within a member having a curved wall extending around the plate, and the light patterns a re reflected to the viewer via said wall.

25. A device according to Claim 23, wherein said reflective member comprises a semi-reflective mirror.

26. A display device according to Claims 23 to 25, wherein said light pattern generator comprises an array of light emitting diodes mounted on a cylinder surrounding said reflective member and directed at said reflective member.

27. A display according to any one of Claims 22 to 25, wherein said light pattern generator comprises a laser beam directed to scan the reflective member via a slot in a cylinder surrounding said reflective member and wherein at least one of said cylinder or reflective member has light dispersing properties.

28. A display system according to claim 27, including a multifaceted rotating mirror for causing the laser beam to scan the slot.

29. A display system according to Claim 27, including an oscillating member for causing the laser beam to scan the slot.

30. A display system according to Claim 29, including a solenoid energisable to displace the mirror about a pivotal point in one sense and a return spring for displacing the mirror about the pivotal point in the opposite sense when the solenoid is de-energised.

31. A display system for being fitted to a member which is subject to turning movement, the display system comprising light pattern generating means, control means including memory means and connected to the light pattern generating means for causing it to produce a sequence of light patterns in accordance with signals stored in said memory means, and position sensing means connected to the control means for sensing the position of the member within said turning movement, the position sensing means comprising an

element which is able to move in response to gravity and signal supply means for supplying an electrical signal indicative of the movement of the element.

32. A display system according to Claim 31, wherein the moveable element comprises electrically conductive material and the signal supply means comprises a pair of contacts within the position sensing means for being bridged by the movable element in one position thereof in its movement.

33. A display system according to Claim 31 or Claim 32, including centrifugal switch means for responding to turning of the said member for initiating operation of the system.

34. A display system according to Claim 31, 32 or 33, said position sensing means being fitted to said member for the movement of the movable element to be transverse to centrifugal force acting on the element due to the turning movement of said member.

35. A display system for being fitted to a member which is subject to turning movement, the display system comprising light pattern generating means, control means including memory means and connected to the light pattern generating means for causing it to produce a sequence of light patterns in accordance with signals stored in said memory means, and position sensing means connected to the control means for sensing the position of the member within said turning movement, the position sensing means comprising an infrared transmitter/receiver combination fixed to said member and operable for co-operating with an item which does not turn with said member, thereby to cause a signal to be produced from the infrared receiver.

36. A display system for being fitted to a member which is subject to turning movement, the display system comprising light pattern generating means, control means including memory means and connected to the light pattern generating means for causing it to produce a sequence of light patterns in accordance with signals stored in said memory means, and position sensing means connected to the control means for sensing the position of the member within said turning movement, the position sensing means comprising radiation sensing means for sensing radiation from separate radiation transmitting means.

37. A toy top, comprising a display system according to Claim 35 or 36.

38. A yo-yo comprising a display system according to Claim 35 and to Claim 36.

39. A model aircraft arranged to fly about a fixed pivot point and comprising a display system according to Claim 35 or to Claim 36.

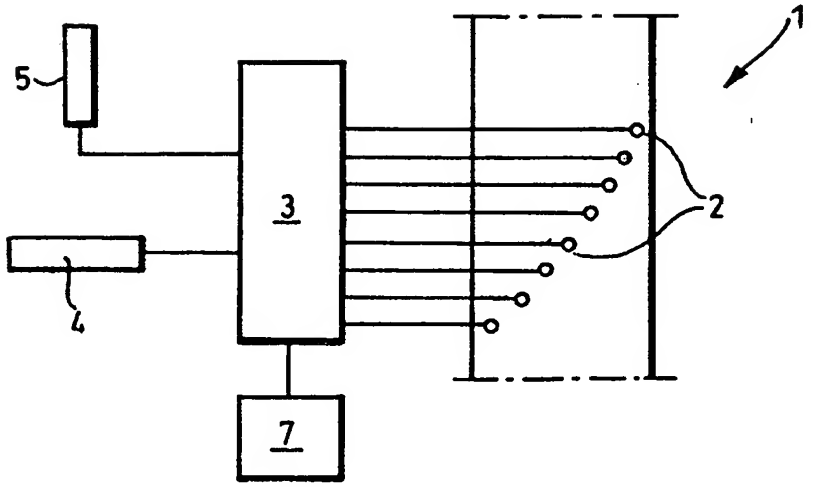

Fig.1.

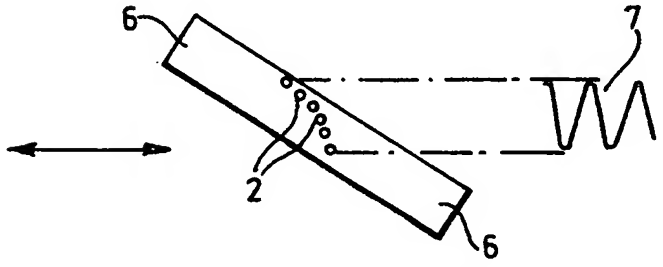

Fig.2.

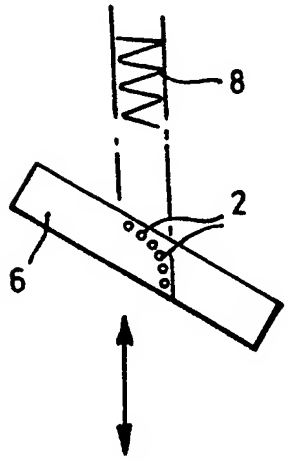

Fig.3.

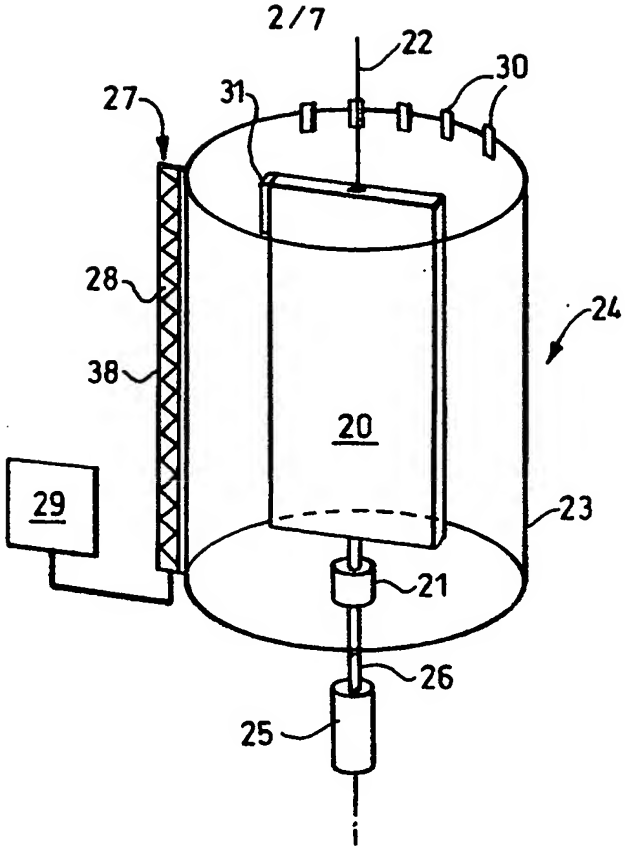

Fig.6.

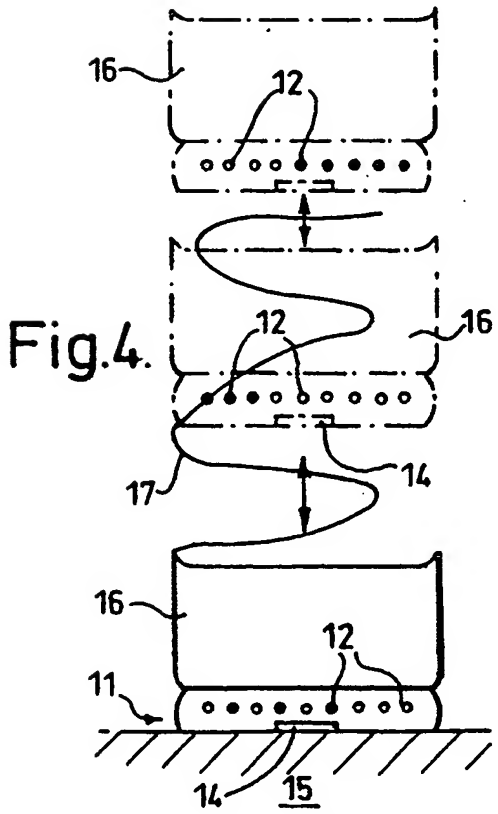

Fig.4.

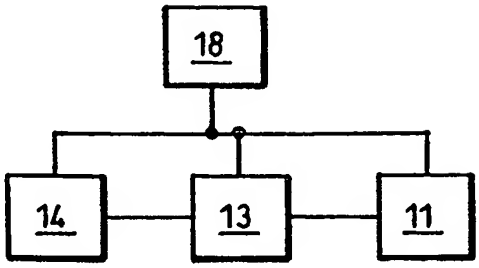

Fig.5.

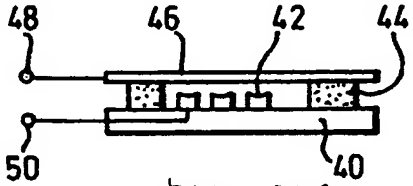

Fig.5A.

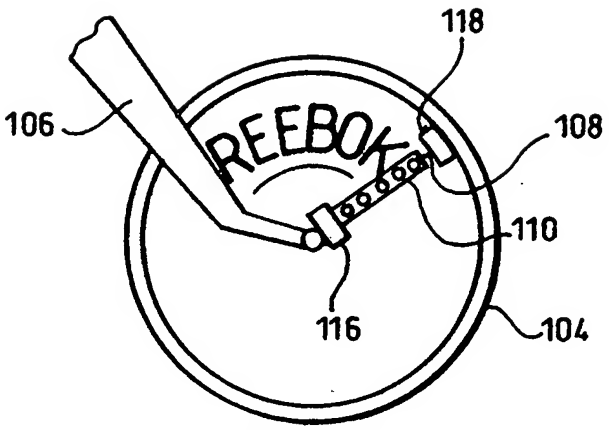
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Fig.7.

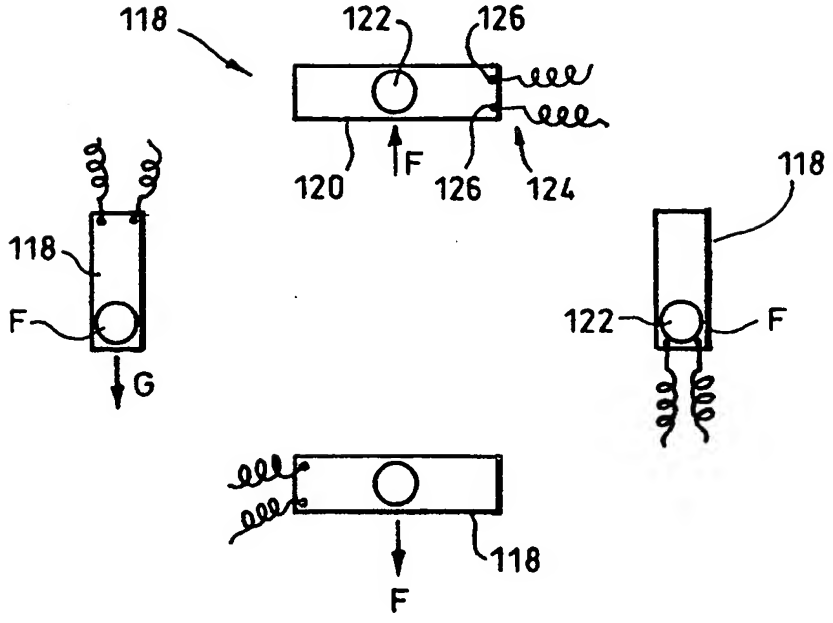
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Fig.9.

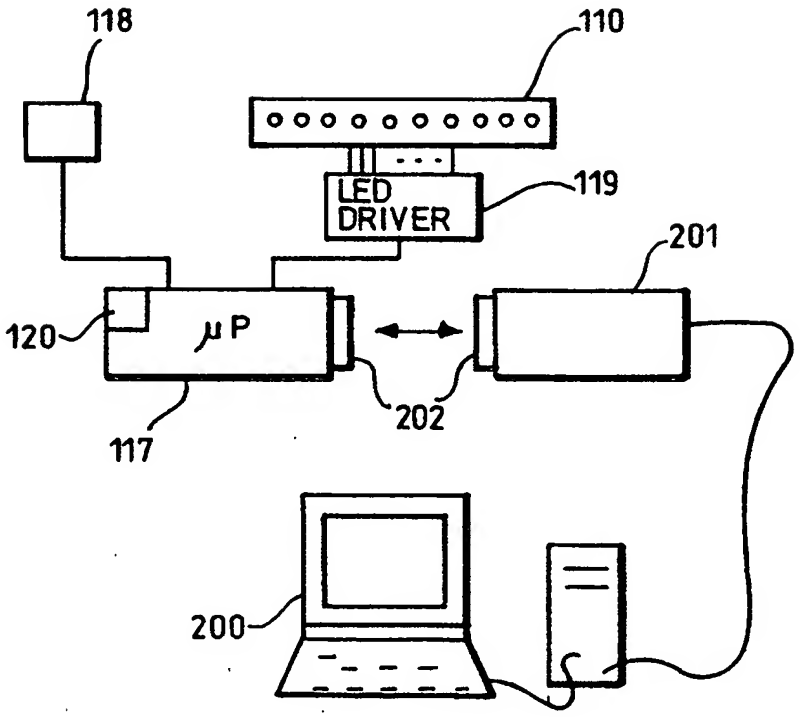

Fig.8.

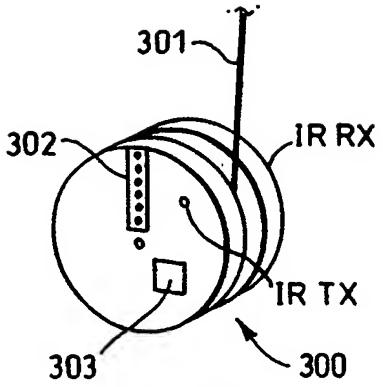

Fig.10.

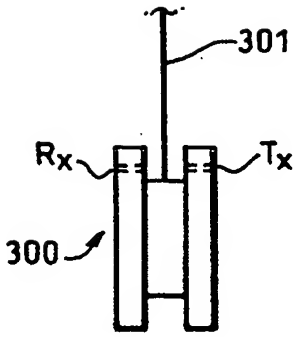

Fig.11.

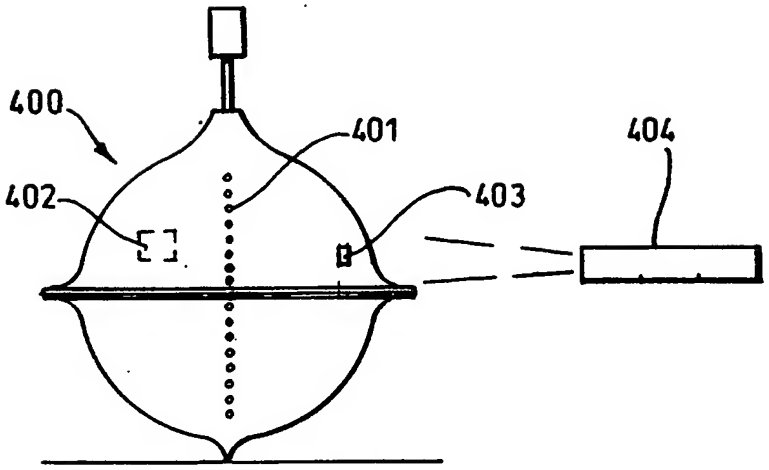

Fig.12.

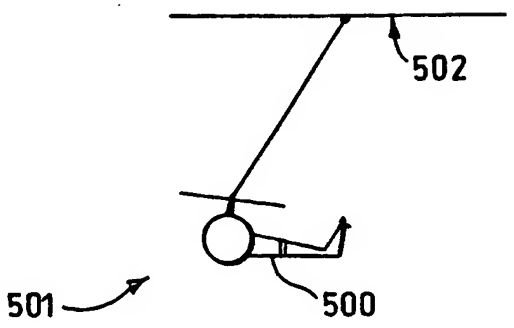

Fig.13.

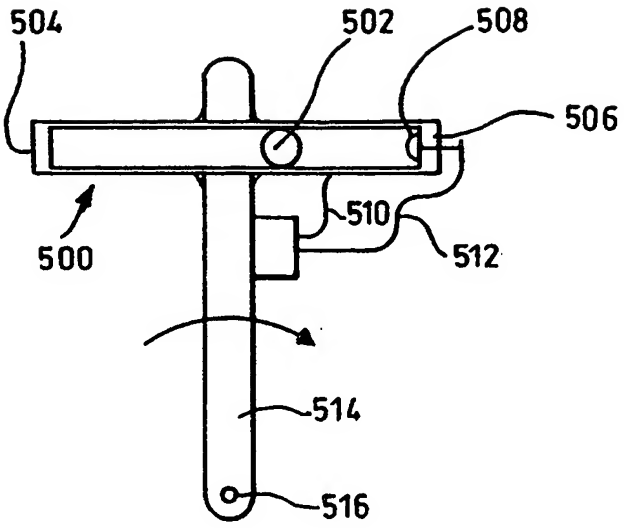

Fig.14.

Fig.14A.

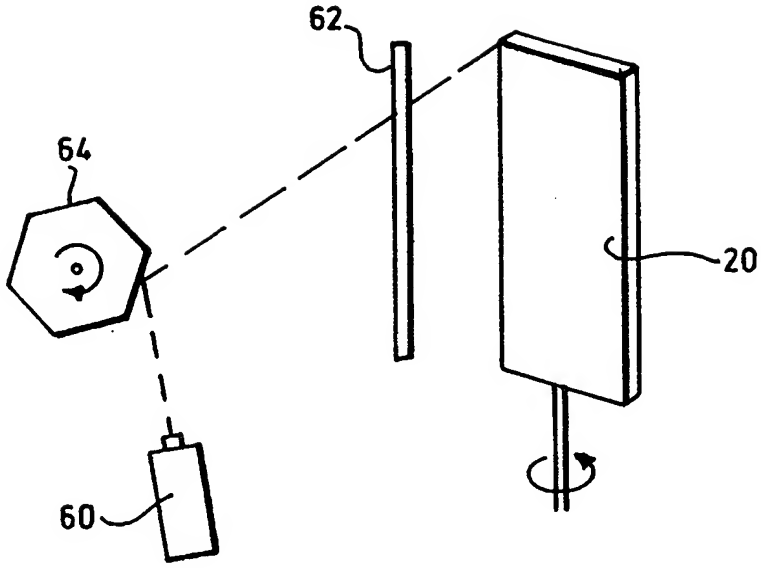

Fig.15.

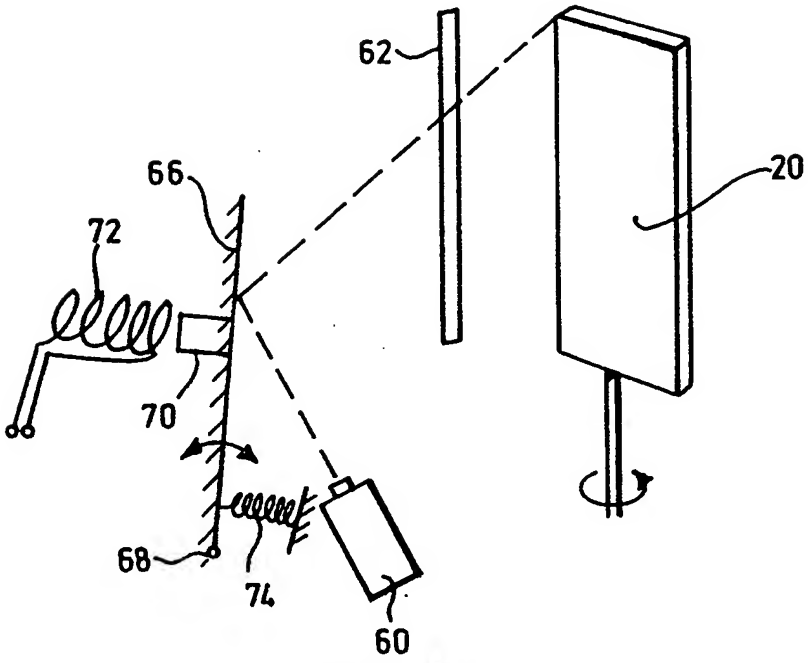

Fig.16.

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 99/03139

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G09G3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 748 157 A (EASON) 5 May 1998 (1998-05-05)	7,13,14, 16, 18-22,35
A	see Abstract column 7, line 21 -column 9, line 8; figures 1-8 column 11, line 41 -column 12, line 46	1-3,5,31
X	G.J.FAN ET AL.: "Scrolling of rotating scanner-LED (ROLED) displays" IBM TECHNICAL DISCLOSURE BULLETIN., vol. 20, no. 1, June 1977 (1977-06), pages 405-406, XP002129371 IBM CORP. NEW YORK., US ISSN: 0018-8689 see the whole article	23

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
1 February 2000	16/02/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Corsi, F

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INTERNATIONAL SEARCH REPORT

Inte. onal Application No
PCT/GB 99/03139

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 791 966 A (CAPPS ET AL.) 11 August 1998 (1998-08-11)	35,37,38
A	see Abstract column 4, line 24 -column 5, line 8; figures 1-6,10,12,16 column 6, line 11 - line 28 column 6, line 57 -column 7, line 9 column 7, line 57 -column 8, line 7	4
A	US 5 444 456 A (MASUO OHTA ET AL.) 22 August 1995 (1995-08-22) see Abstract column 4, line 27 - line 31; figure 1 column 4, line 52 - line 57; figure 6 column 4, line 67 -column 5, line 59; figures 9-11B	1-3,31, 32,34
A	US 5 214 413 A (OKABAYASHI ET AL.) 25 May 1993 (1993-05-25) see Abstract column 4, line 7 - line 27; figure 2	28,29

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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